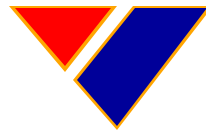


ENVIRONMENTAL QUALITY PROGRAM OVERVIEW

Jeff Grovhoug
Environmental Sciences Division
7 May 2001

SPAWAR



*Systems Center
San Diego*



ENVIRONMENTAL QUALITY RDT&E PROGRAM

SPAWAR SYSTEMS CENTER SAN DIEGO

Environmental Sciences Division (D36)





ENVIRONMENTAL SCIENCES DIVISION

- **Focus: RDT&E and Direct Support in Environmental Quality Assessment and Remediation With Emphasis in the Marine/Estuarine Environment**
- **38 Scientists and Engineers in Environmental Programs**
 - ◆ **Two-thirds advanced degrees, broad number of disciplines**
 - ◆ **In-house delivery order contract for technical support**
 - ◆ **Multi-disciplinary approach to environmental R&D/support**
- **Vertically integrated programs Basic Research (6.1), applied research,(6.2,6.3), Dem/ Val (6.4), OMN, ER,N**
- **Marine Environmental Support Office: Provides Direct Support to Fleet and Facilities in marine related issues**
- **Laboratory location and unique assets facilitate effective and rapid environmental assessments**



Environmental Quality Program

Environmental Quality (EQ) Technology RDT&E

■ **Goals**

- ♦ **Reduce cost of environmental compliance, cleanup and oversight**
- ♦ **Minimize the risk of environmental impact from Navy operations and facilities & reduce risk to Navy operations from environmental regulations**
- ♦ **Develop capability to produce scientifically sound data and risk analysis to support Navy environmental compliance**
- ♦ **Develop improved assessment, monitoring and remediation technology for environmental restoration and compliance**



MARINE ENVIRONMENTAL SURVEY CAPABILITY

- MESC is a system of sensors and real-time data acquisition designed to measure water quality
- The system provides integrated measures of hydrographic, conventional water quality, and contaminant data at spatial and temporal scales appropriate to the dynamics of estuarine and marine systems
- MESC provides the synoptic data required to assess the processes controlling the fate and transport of contaminants

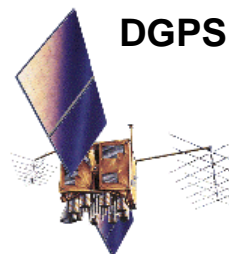


MESC System Schematic

Systems Center
San Diego

Sensors

4-Hz, Sub-meter
Direct, Sensitive



DGPS

Towed Sensors



On-Board Sensors



ADCP



Parameters

Multiple integrated
and simultaneous

Hydrographic:

- Salinity
- Temperature
- Sample Depth
- Bottom Depth
- Density
- 3-D Currents
- Wind velocity

Conventional Water Quality:

- Total Suspended Solids
- Particle size
- Chlorophyll-a
- Dissolved Oxygen
- pH

Contaminants:

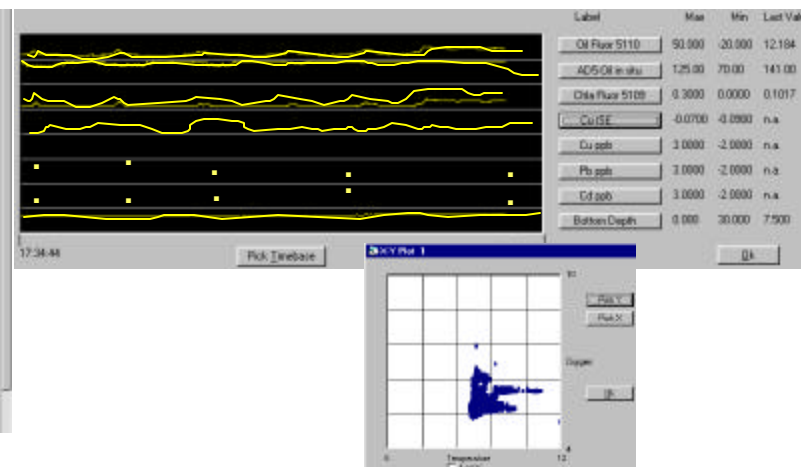
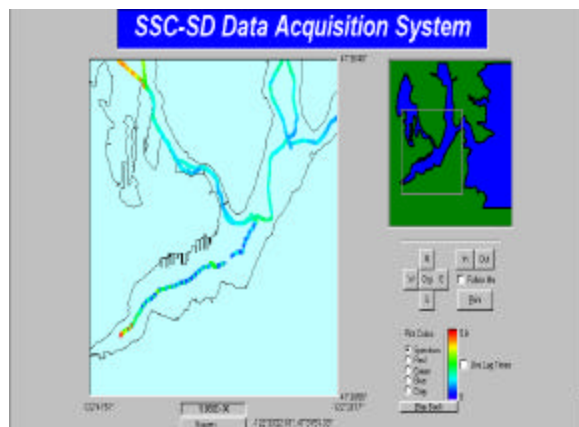
- Trace Metals - Cu, Pb, Cd
- Polynuclear Aromatic Hydrocarbons

Other Measures:

- Simultaneous discrete sampling

Real-Time Displays

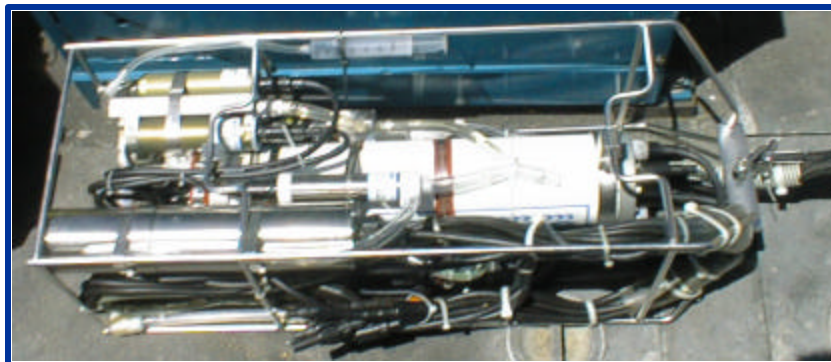
Multiple displays
for real-time
assessment





MESC System Components

Towed Sensors



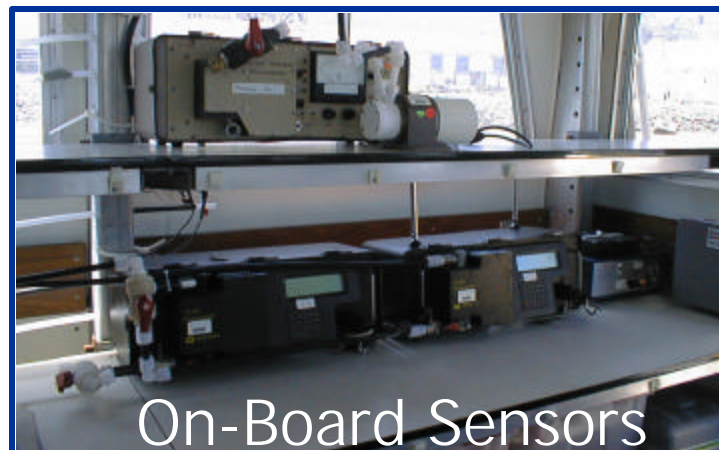
Computer Acquisition



MESC aboard RV ECOS



On-Board Sensors



Trace Metal Analyzer





Demonstrated MESC Projects

Data Gathering on over 160 surveys for:

Ecological Risk Assessment- Portsmouth Naval Shipyard

Hydrodynamic Modeling Validation- San Diego Bay (TRIM), Piscataqua River (DYNHYD3), Sinclair Inlet (CH3D)

Wake Modeling Validation- Shipboard solid waste discharges (TBWAKE, SEDXPORT)

Long Term Monitoring- Naval Station San Diego,

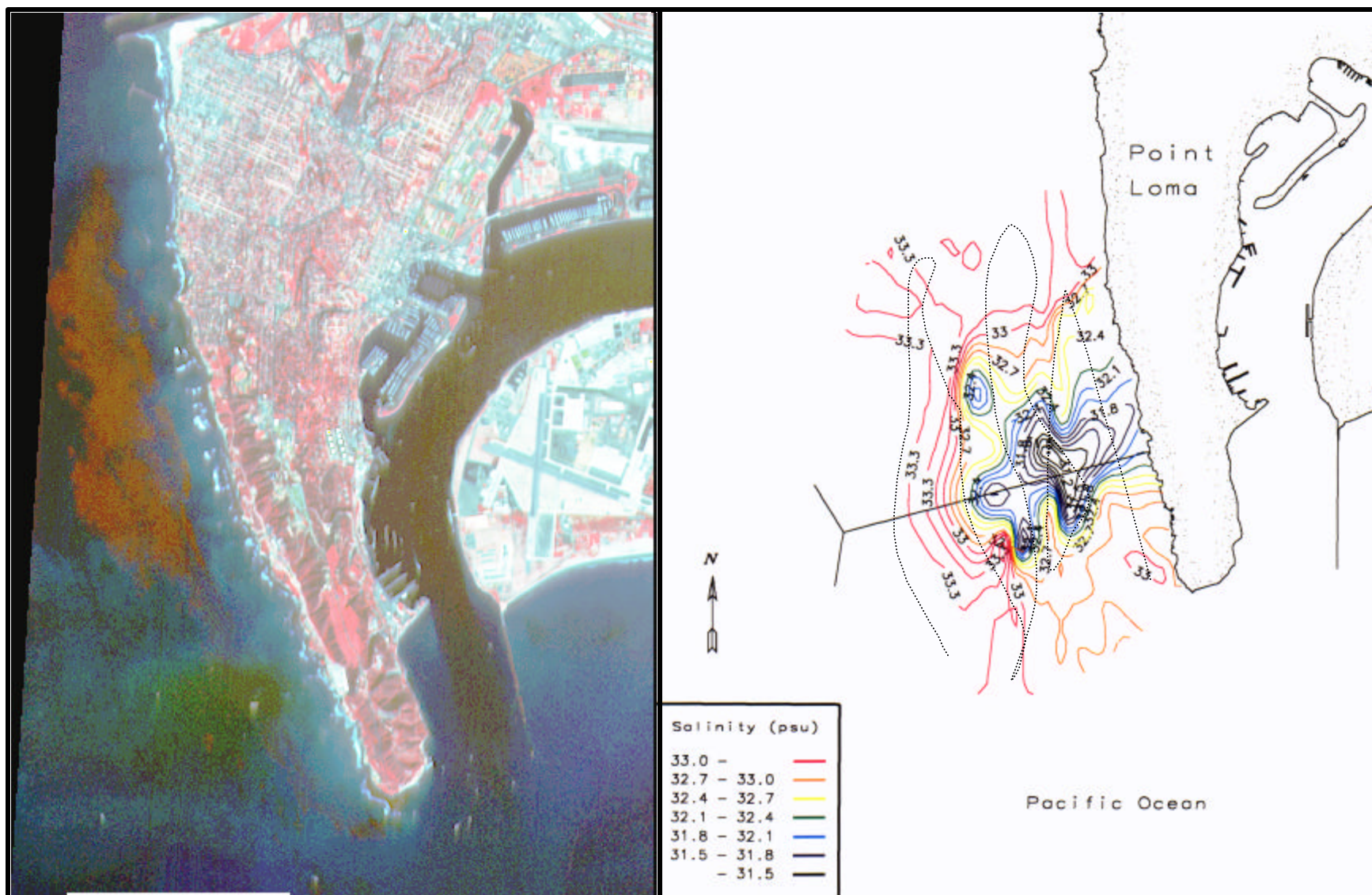
Stormwater Monitoring- Puget Sound Naval Shipyard, NAVSTA and Sub Base San Diego

Plume Tracking- Compensating fuel system discharges, oil spills, sewage treatment plant outfall, ship resuspension, water mass tracking

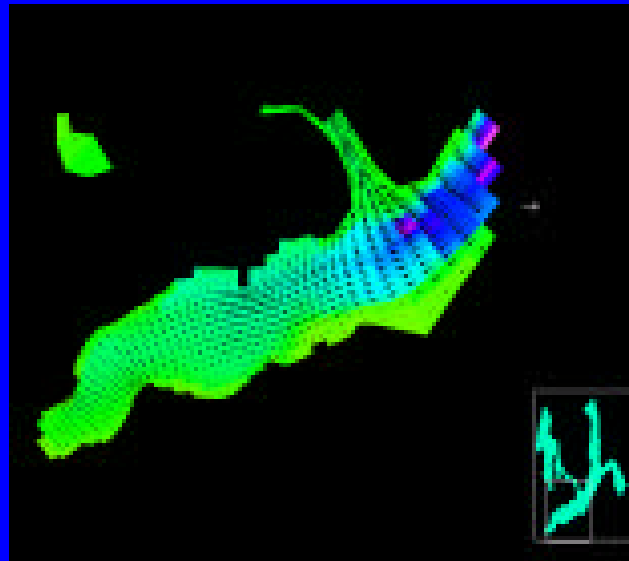
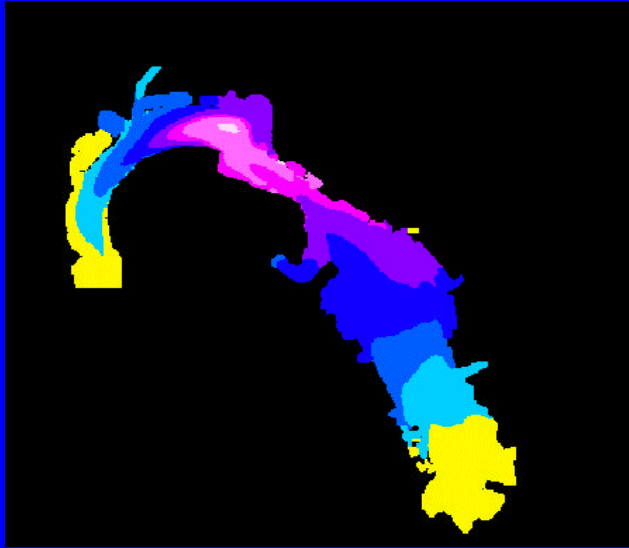
Remote Sensing Validation- San Diego Bay mapping with NRL, seawater optics for hyperspectral overflights

Project Support- Benthic flux, in-water hull cleaning, pore water and sediment (RSC) sampling

Plume Tracking/Remote Sensing Sewage Spill



Modeling Contaminant Fate and Transport in Estuaries



Model Applications:

- Calibrate hydrodynamic and transport model
- Simulate hydrodynamics (currents, freshwater inflow and wind effects, ... etc.)
- Contaminant and sediment fate and transport
- Mixing of effluent discharge for discharge permit
- Oil-spill trajectory predictions
- Total Maximum Daily Load (TMDL) study



Thrust: Environmental Chemical Sensors and Toxicity Assessment

NEED:

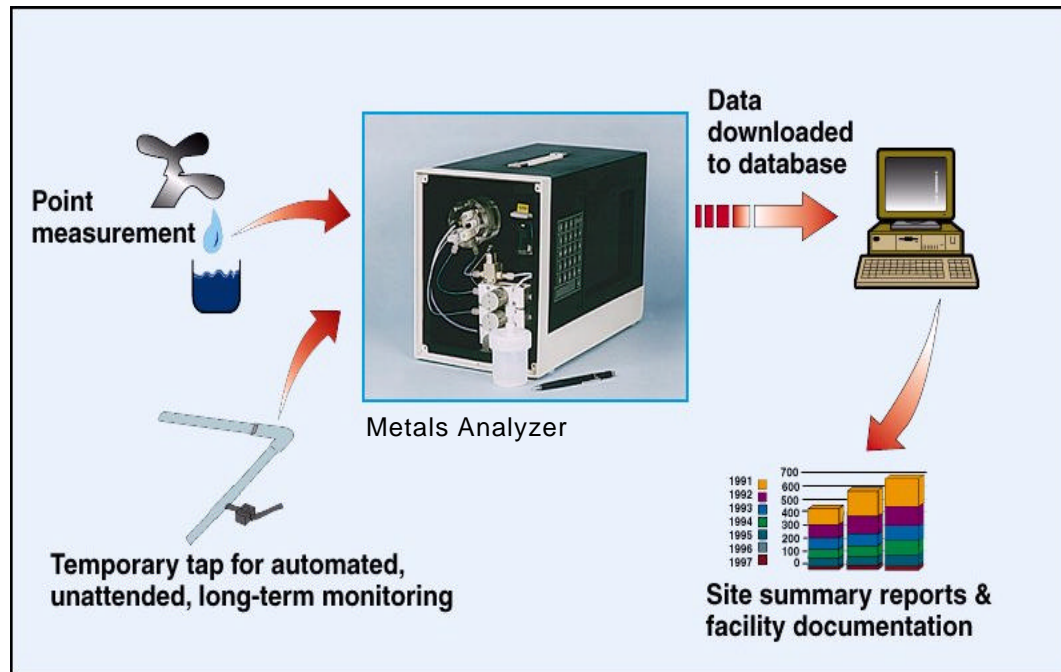
- Increasing requirements for monitoring
- Faster cheaper site assessment technology
- Shift to toxicity-based permit monitoring

NAVY DRIVERS:

- Reduce costs of monitoring & site assessments
- Need for improved (faster, more relevant) assessment methods
- Standardized methods for marine monitoring
- Support cost-effective compliance/pollution prevention engineering designs
- Cost-effective monitoring to prevent pollution

Environmental Sensor/Instrument Development

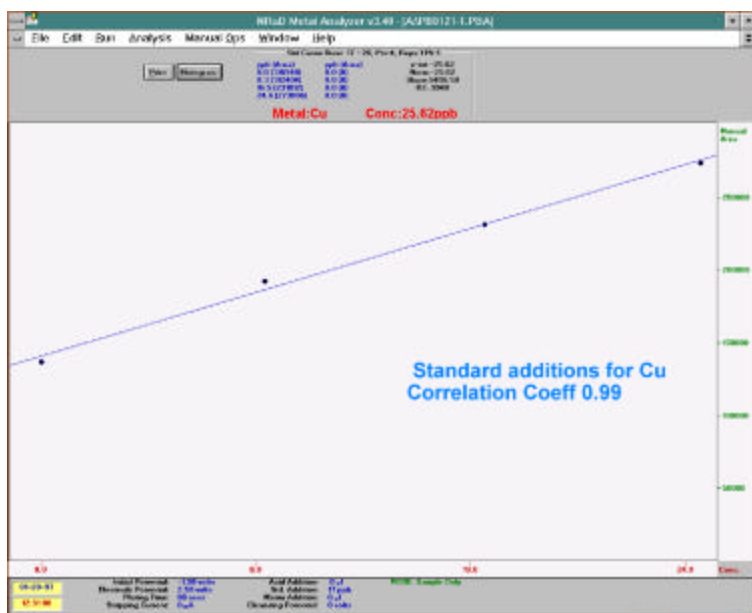
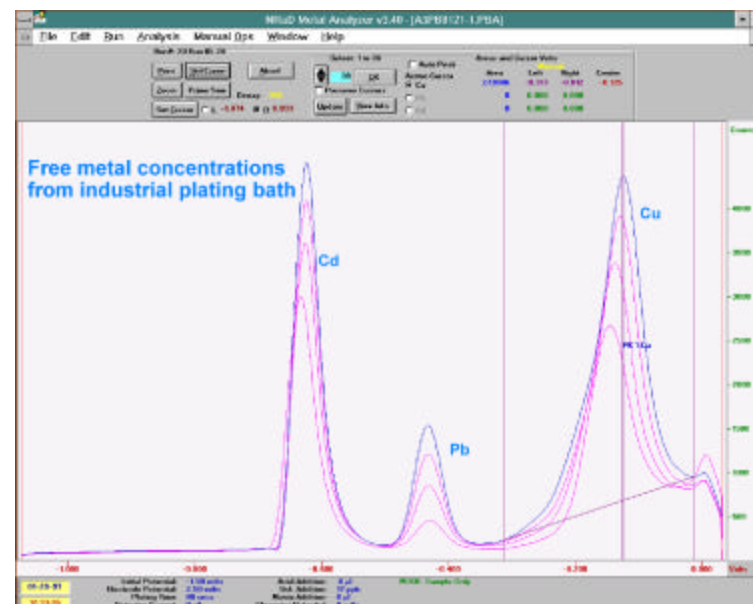
- To develop the capability to quickly and cost effectively assess the composition and toxicity of materials released by ship and shore operations



QwikLite Toxicity Test

- Automated trace metal/organometal analyzers
- Bioluminescent measurement of toxicity (QwikLite)
- Advanced oil content monitoring for ships and oil spills
- Laser-induced fluorescence for POL detection in soils and marine waters
- Fiber-optic spectral analysis for metals and chlorinated solvents in soils and groundwater

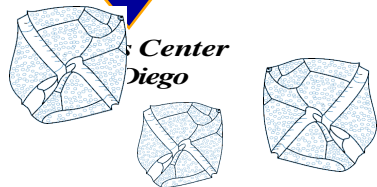
Trace Metals Analyzer



- Potentiometric Stripping Analysis
- Multiple trace metals at ppb levels
- Automated for real-time analysis on 6-minute intervals
- Seawater measurements of Cu, Pb, Cd and Zn.



The QwikSed System

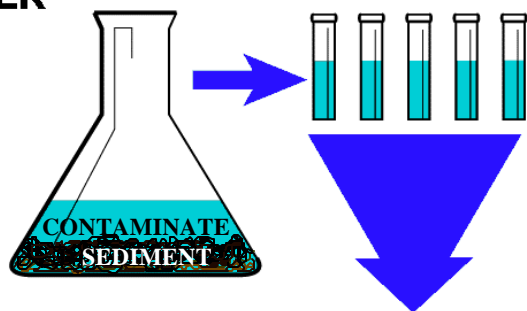


Center
Diego

CELLS

ELUTRIATES &
PORE WATER

SEA
WATER



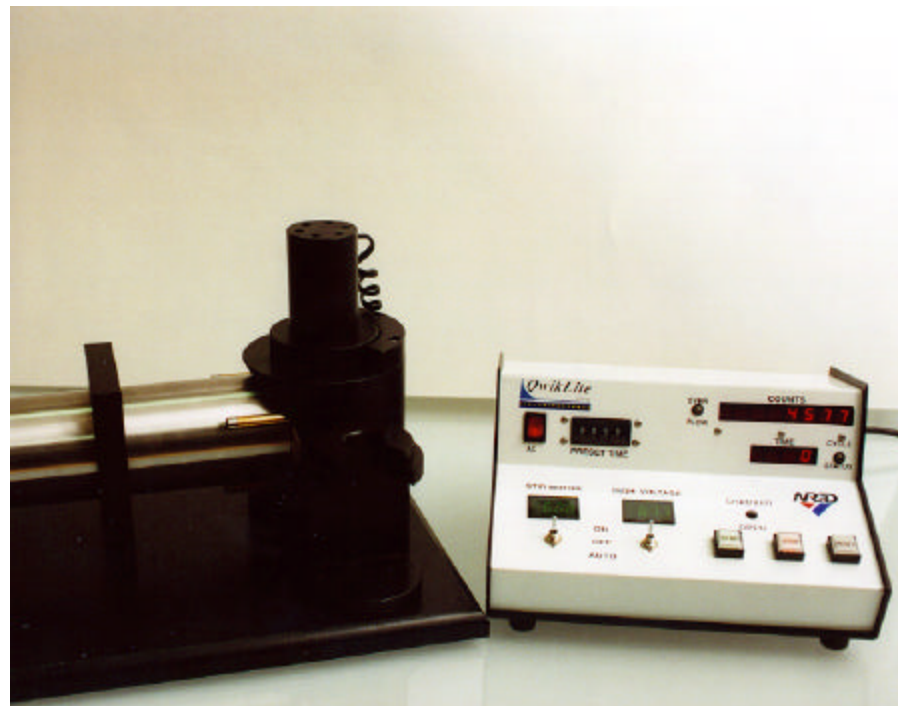
STIR MOTOR

PLASTI
CCUVET
TE

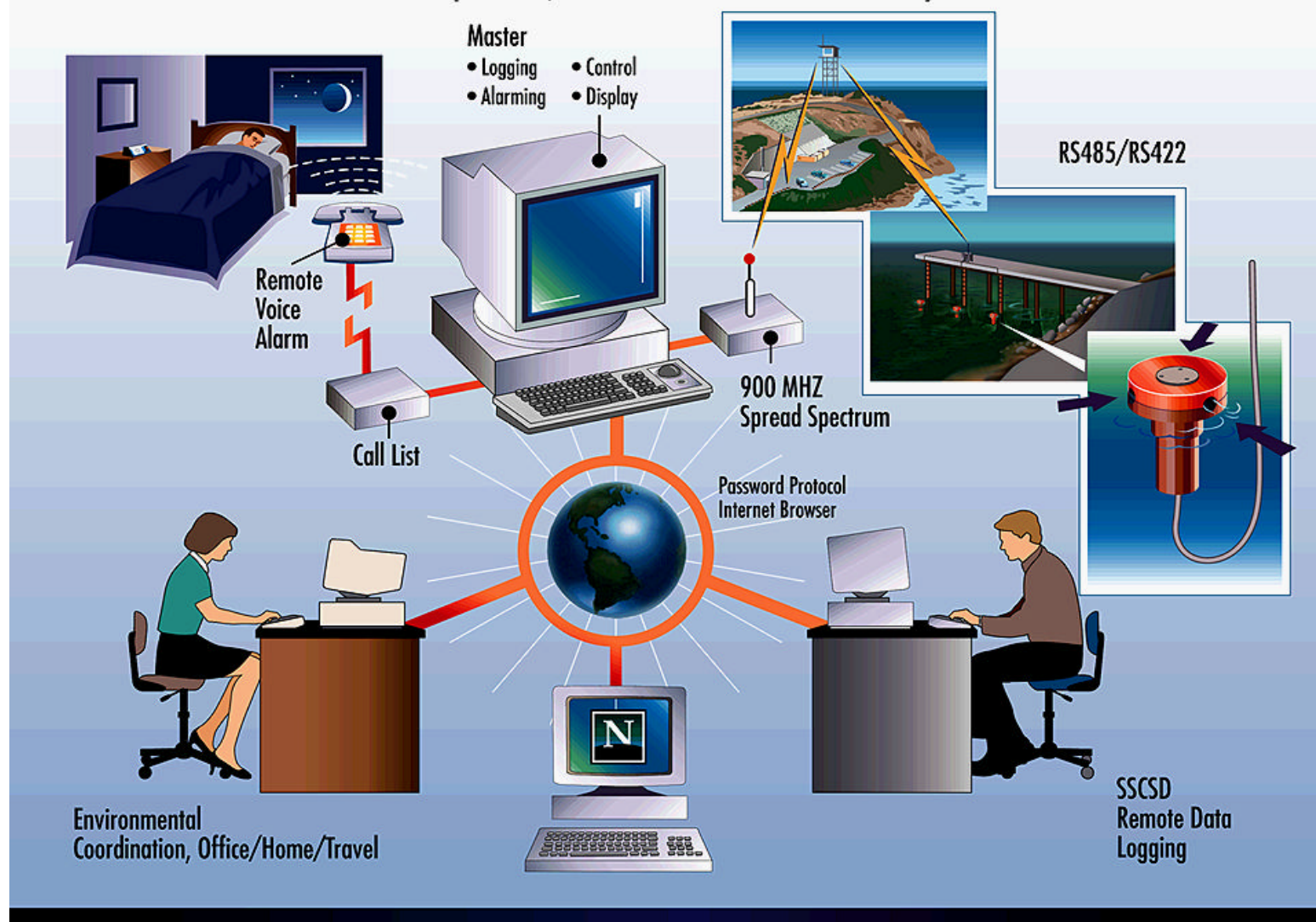
CELLS

STIRRE
R

LIGHT
DETECTOR
(PMT)



Data Acquisition, Control and Communication System



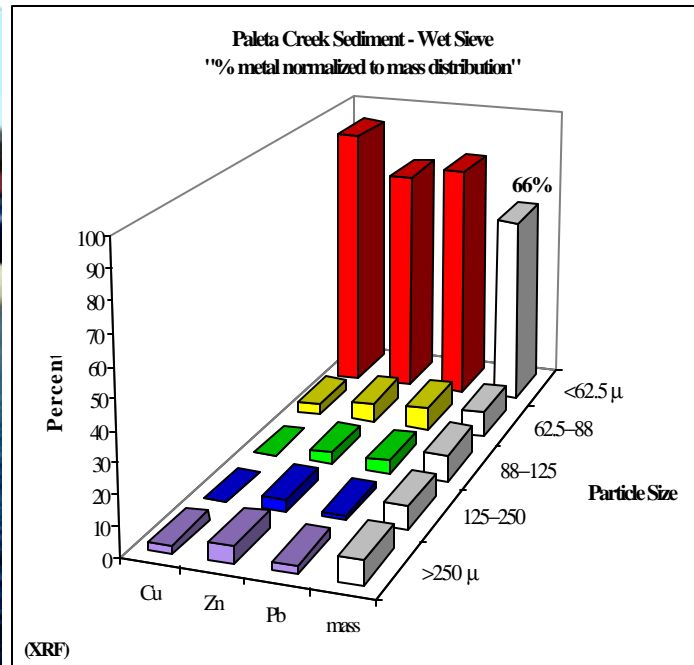
Sediment Assessment and Treatment Technology

- To assess contaminant distribution throughout an area, and the sediment/contaminant interactions that will control treatability and management

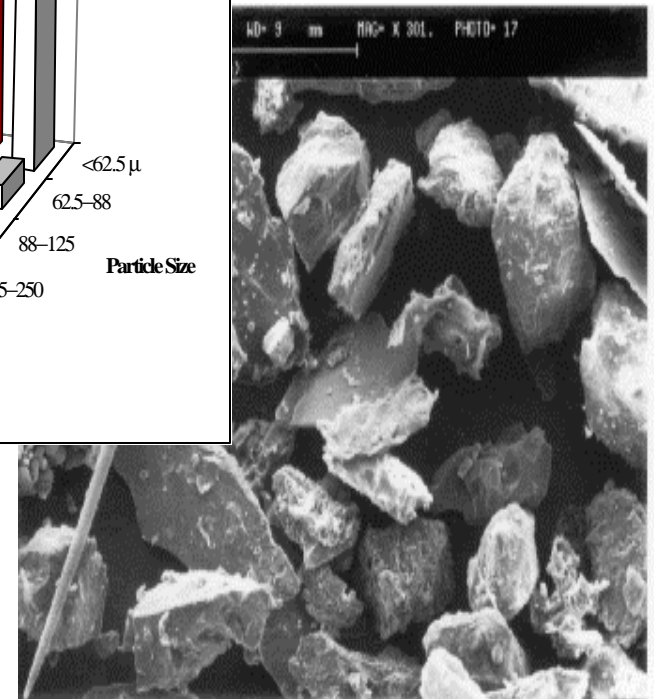


Benthic Flux Sampling Device

- Bioremediation and particle separation technology
- Sediment assessment prediction and monitoring techniques
- Sediment contaminant biogeochemistry
- Benthic contaminant flux/seepage sampling and measurement
- Rapid sediment characterization/screening



Sediment contaminant size distribution



Sediment Characterization (SEM 300X)



Thrust: Sediment Assessment and Remediation

Sediment: Receiving System for Most Contamination

Assessment: Rapid ID, Localization & Toxicity of Contaminants

Remediation: Treatment or Removal Technology

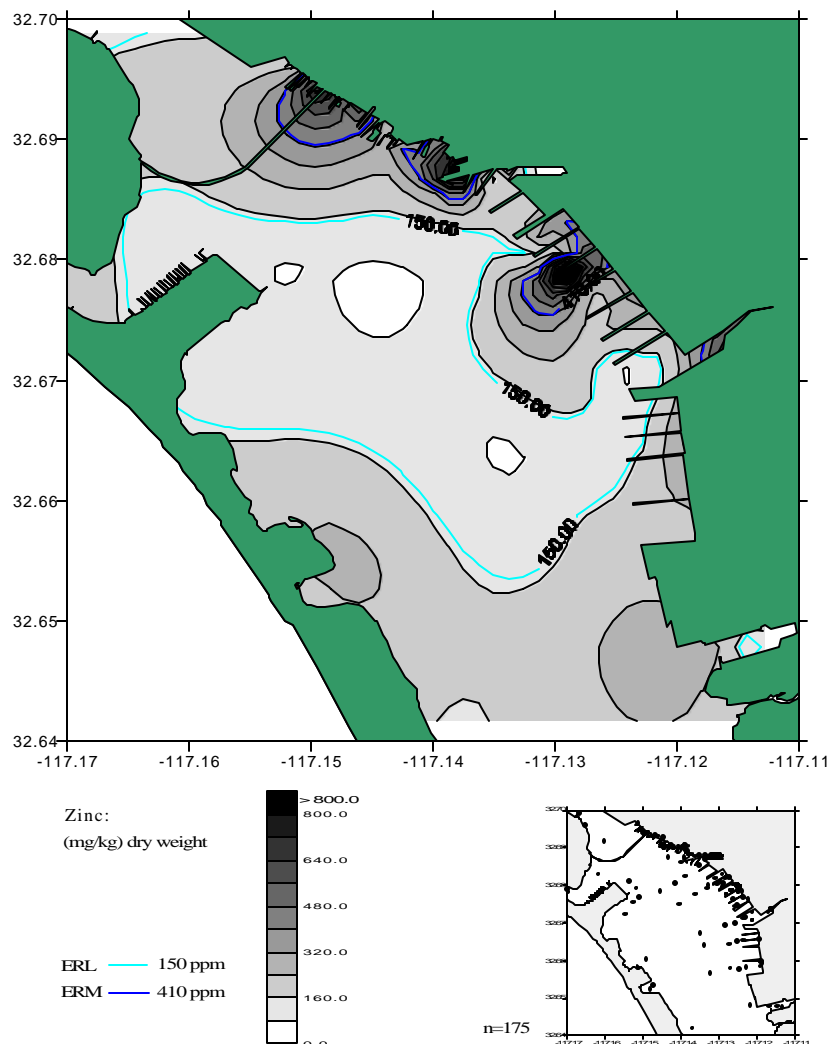
NEED:

- Contaminated sediments can impact human & (or) ecological health
- Dredging stopped/delayed, dumpsites closed, contruction stopped or delayed & sediment cleanups are very expensive
- Regulator concern/oncoming sediment standards

Rapid Sediment Characterization

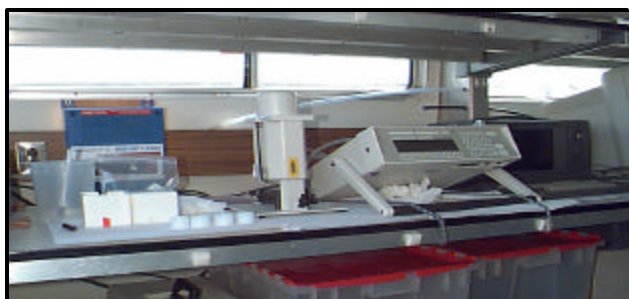
- **Chemical and Biological Tools**
 - **X-Ray Fluorescence (XRF) for Metals**
 - **UV Fluorescence for Organics (PAHs)**
 - **QwikLite Bioassay for Biological Effects**
- **Utilize Rapid Sediment Characterization (RSC) along with standard lab data to:**
 - ♦ **Reduce number of costly laboratory analyses**
 - ♦ **Map contaminated sediment volumes more efficiently (at less than 50% of current costs) to reduce remediation costs**
 - ♦ **Increase the probability of successful, high impact sampling**
 - ♦ **Provide the ability to fill in gaps and reduce uncertainty at several steps of the RI/FS process without the enormous cost of traditional resampling efforts**

INTEGRATED FIELD SCREENING FOR RAPID SEDIMENT CHARACTERIZATION



- **Description:** Integrated screening methodology to map the distributions of multiple chemicals and their related biological effects.
- **Benefits:** Costs 10-50% of lab analyses, with higher data density for mapping. Near real-time data guides field operation, less blind sampling.

INTEGRATED FIELD SCREENING FOR RAPID SEDIMENT CHARACTERIZATION



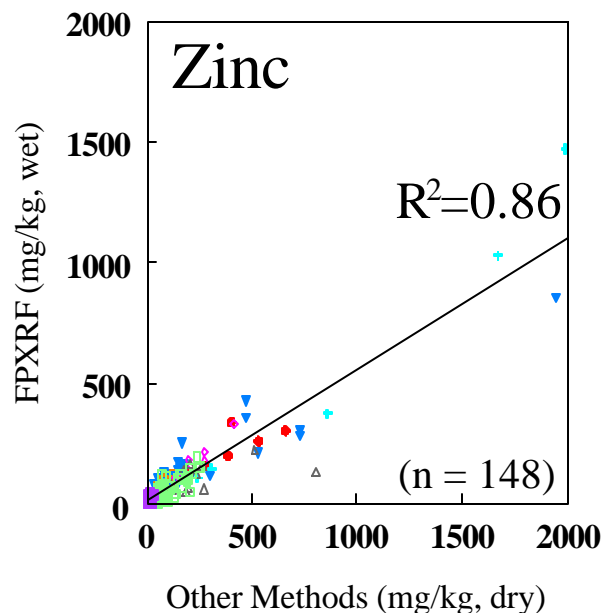
X-Ray Fluorescence



UV Fluorescence



QwikLite

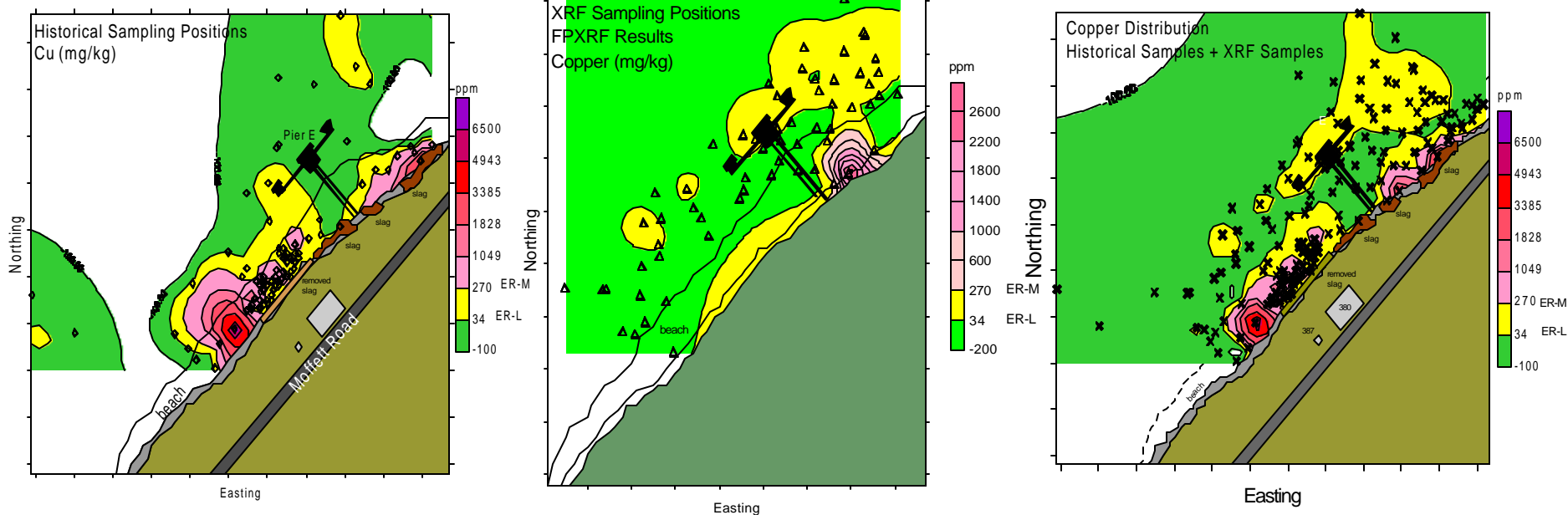


- Field Portable X-Ray Fluorescence (FPXRF) for Metals
- UV Fluorescence (UVF) for PAHs (found in petroleum)
- Incorporates QwikLite to screen for the biological effects of bioavailable contaminants, detected or not by chemistry



Rapid Sediment Characterization: Metals

NAS North Island Remedial Investigation



Historical Delineation + XRF Delineation = Complete Delineation at Site

- RPMs and regulators were concerned that impact from copper slag in shoreline sediments might extend beyond sampled

- XRF results 1) filled in data gaps, 2) confirmed hotspots near Pier E and 3) showed that copper did not extend beyond beach area

Sediment Contaminant Flux and

What is it? Is it mobile? Mobility Assessment

- **Benthic Flux Sampling Device**
 - ◆ **Measure diffusional fluxes of contaminants between sediment and overlying water**
- **Diver-Deployed Pore-Water Probe**
 - ◆ **Measure interfacial water concentrations at a specified depth within the sediment**
- **Multi-Sample Seepage Meter**
 - ◆ **Measure groundwater/contaminant seepage in regions of tidal influence**

Background & Motivation

■ Benthic Flux Sampling Device

- 🚗 **Contaminated sediments often assumed to be a source of ongoing pollution and a significant contribution to pollution budgets (TMDLs)**
- 🚗 **Estimation of diffusional fluxes by gradient measurements is difficult due to fine scales and confounding effects (bioturbation)**

■ Diver-Deployed Pore-Water Probe

- 🚗 **Point-of-compliance for contaminants entering via sediments is difficult to monitor**
- 🚗 **Processing of sediment cores often leads to artifacts in porewater concentrations, especially for volatiles**

■ Multi-Sample Seepage Meter

- 🚗 **Groundwater migration and associated contaminant migration is difficult to model or predict from shoreside wells**
- 🚗 **Difficult to monitor capping without compromising cap integrity**



SEDIMENT CONTAMINANT FLUX AND MOBILITY ASSESSMENT

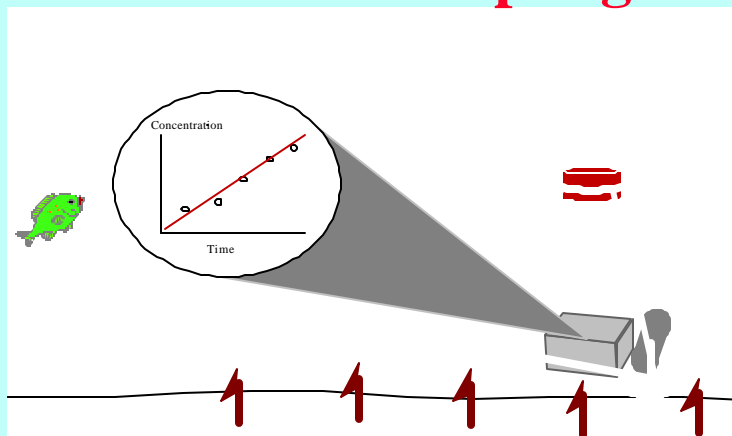
■ BENEFITS:

- Streamline the remedial investigation/feasibility study phase by addressing the true nature and scope of the problem.**
- Cost savings associated with reduction/elimination of long-term monitoring requirements based on better delineation of containment/migration pathways.**
- Cost savings associated with reduction/elimination of clean-up requirements based on better quantification of exposure and risk.**

Are Contaminants Mobile?

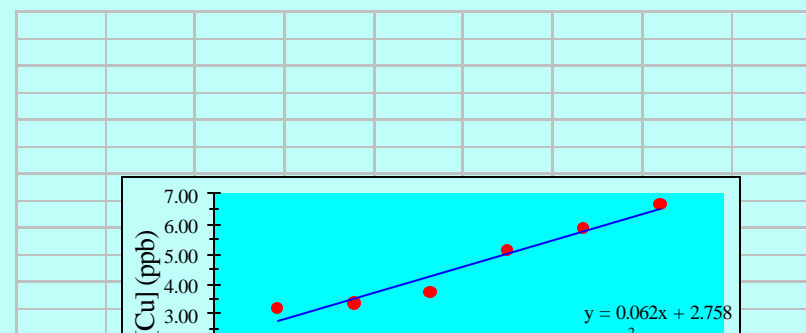
Advanced Sediment Assessment Methods

Benthic Flux Sampling Device (BFSD)



Concept:

Direct measurement of
contaminant mobility
from sediments



Field Testing & Demonstration:

Distinguish and quantify
remobilization for contaminants
of importance at Navy sites

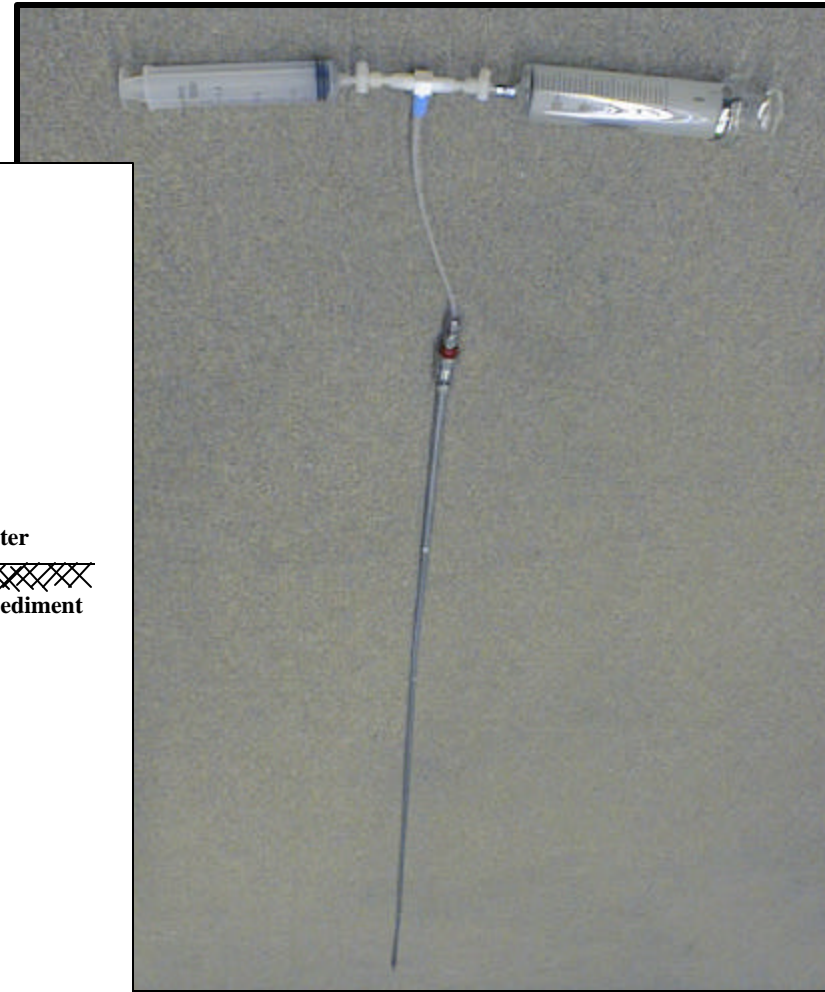
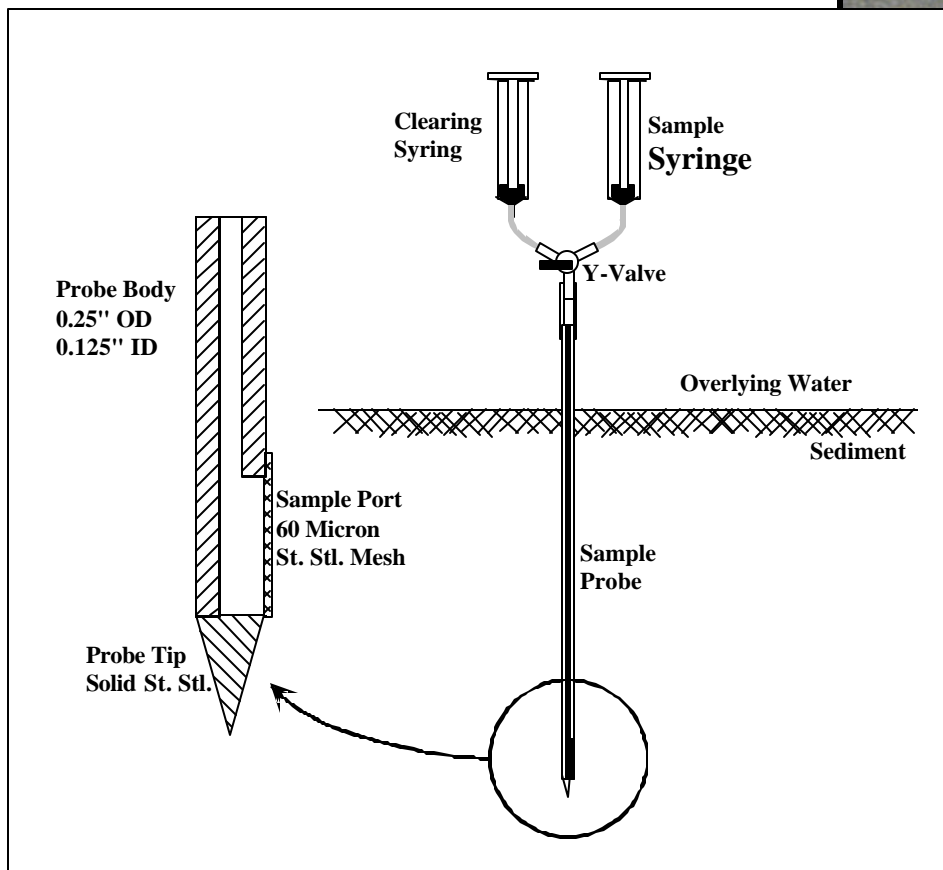


Prototype:

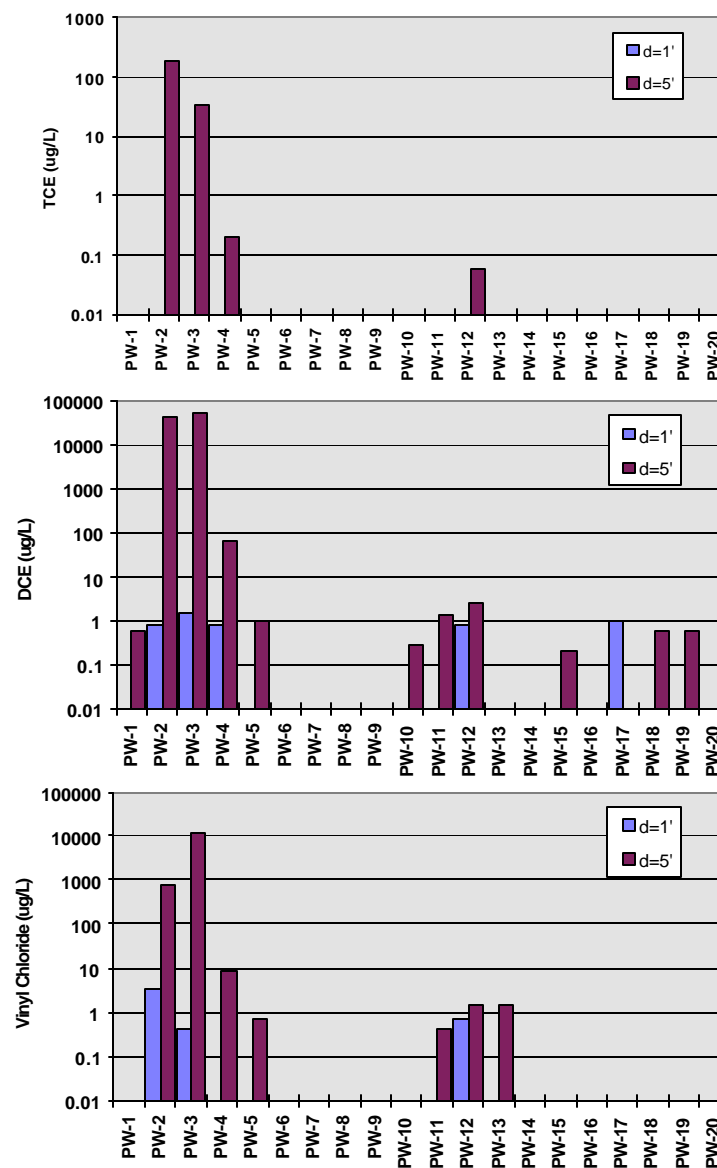
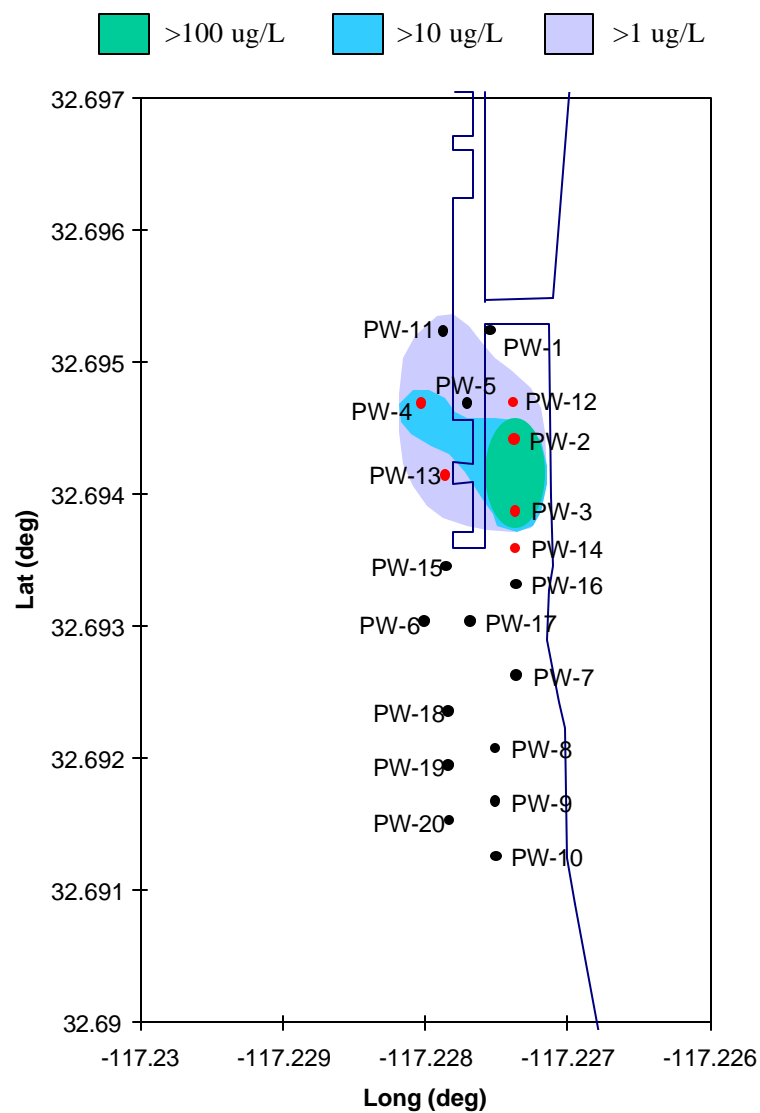
Designed to measure
contaminant fluxes in
harbors and coastal waters



Prototype Pore-Water Sampler



Pore-water Results (Preliminary)

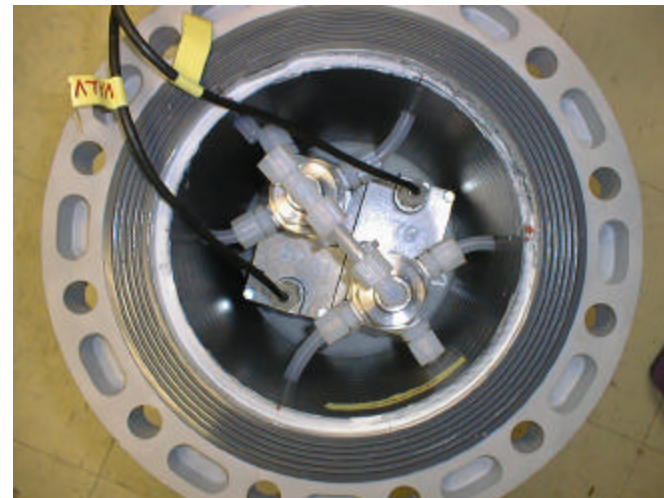
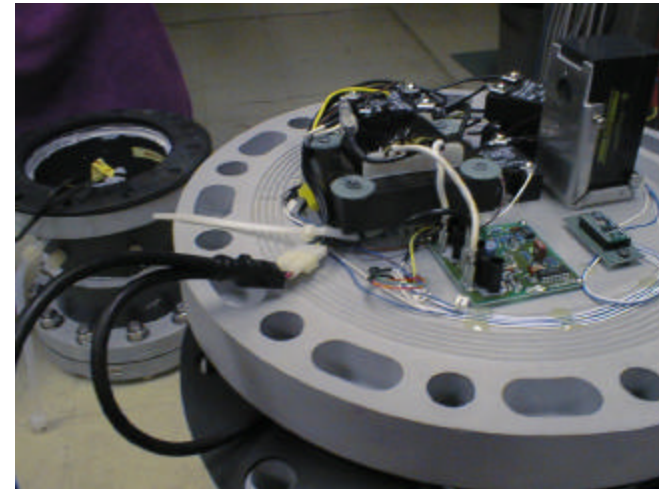




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San Diego

Is it mobile?

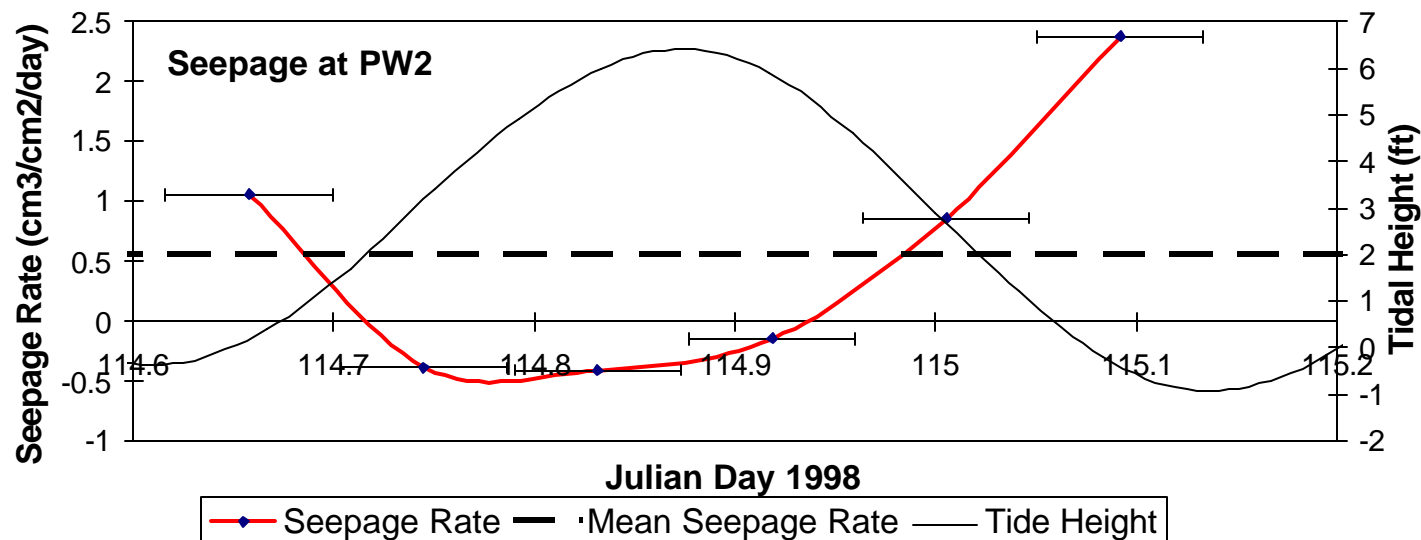
Prototype Multi-Sample Seepage Meter



POC: Dr. Bart Chadwick

Tidal Seepage Results (Preliminary)

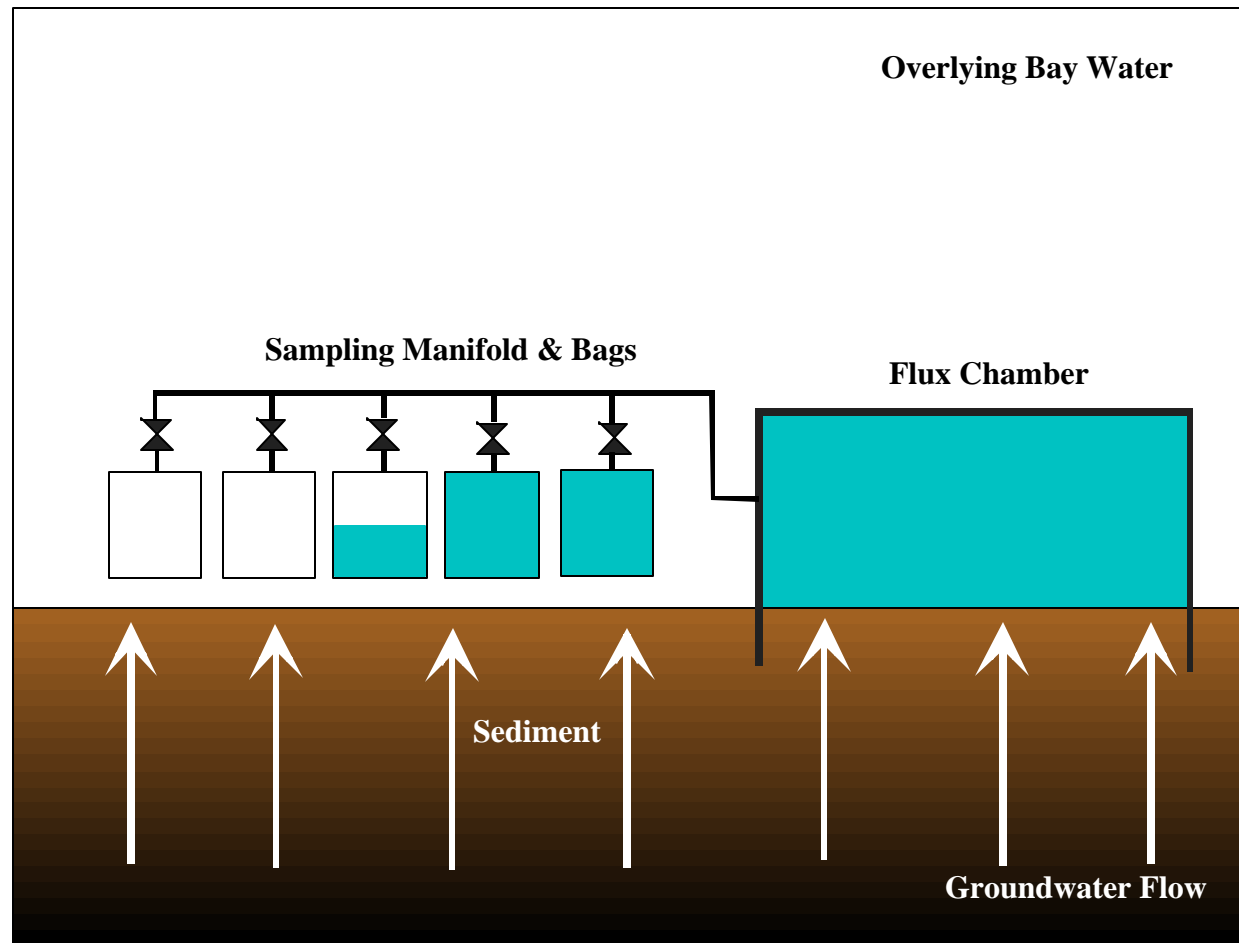
- Results at North Island NAS show strong tidal variation in groundwater migration at all stations
- Multi-sample technique allows tidal variations to be resolved



Multi-Sample Seepage Meter - Concept

◆ Resolve tidal variations in seepage

◆ Determine rate and concentration of groundwater contaminant migration from sediment





Technical Support Model



San Diego Bay Regional Environmental Support Efforts

- **Developed San Diego Bay Data Base (255K records)**
- **Bay Hydrodynamic/ Contaminant Transport Model (Developed and Validated)**
- **Water Quality Mapping of ambient surface waters (PAH's, Copper, etc.)**
- **Support of Regional Monitoring-S. Calif. Bight 98'**
- **Ship Effluent/In-water Hull Cleaning Monitoring**
- **Assessment of Copper loading in San Diego Bay**
- **Supporting COMNAVREGION SW development of general Navy NPDES permit**
- **Organotin Monitoring of water, sediment and bivalves**
- **NASNI Offshore Remedial Investigations-Innovative tech**



Elimination of Chronic Navy Oil/PAH Sources to San Diego Bay

■ Sources of Oil and PAHs include:

- ◆ Storm runoff (non-point sources)
- ◆ In-water gravity oil-water separators -Historical source
- ◆ Leaching from creosote impregnated pilings
- ◆ Oil spills

■ Pollution Control Efforts:

- ◆ Creosote pier pilings are being replaced with plastic, concrete or untreated wood pilings >50% removed
- ◆ Gravity oil-water separators have been entirely replaced with collection systems and shore treatment
- ◆ Substantial efforts to reduce spills and non-point sources

■ Efforts have resulted in significant declines in petroleum hydrocarbons and dissolved PAH's in San Diego Bay

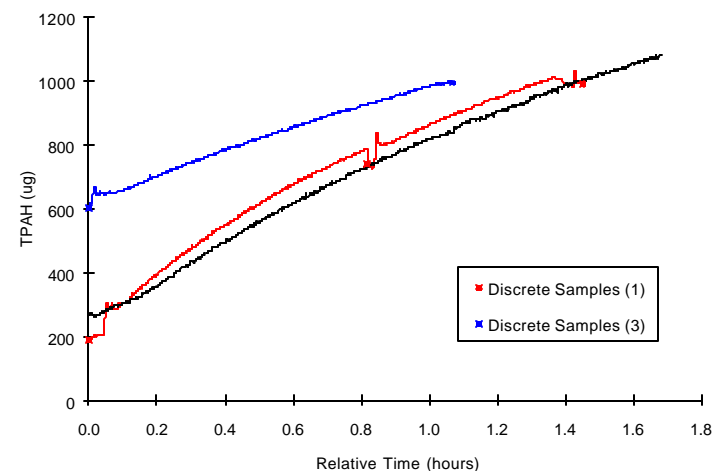


Donuts had previously been used as a method of separating oil from bilgewater and are being removed as part of a Navy initiative to improve the quality of water in its ports. *Photographer - PH3 Michael A. Myers, Pacific Fleet Imaging Facility, Alameda.*

PETROLEUM HYDROCARBON/PAH SOURCE REDUCTIONS

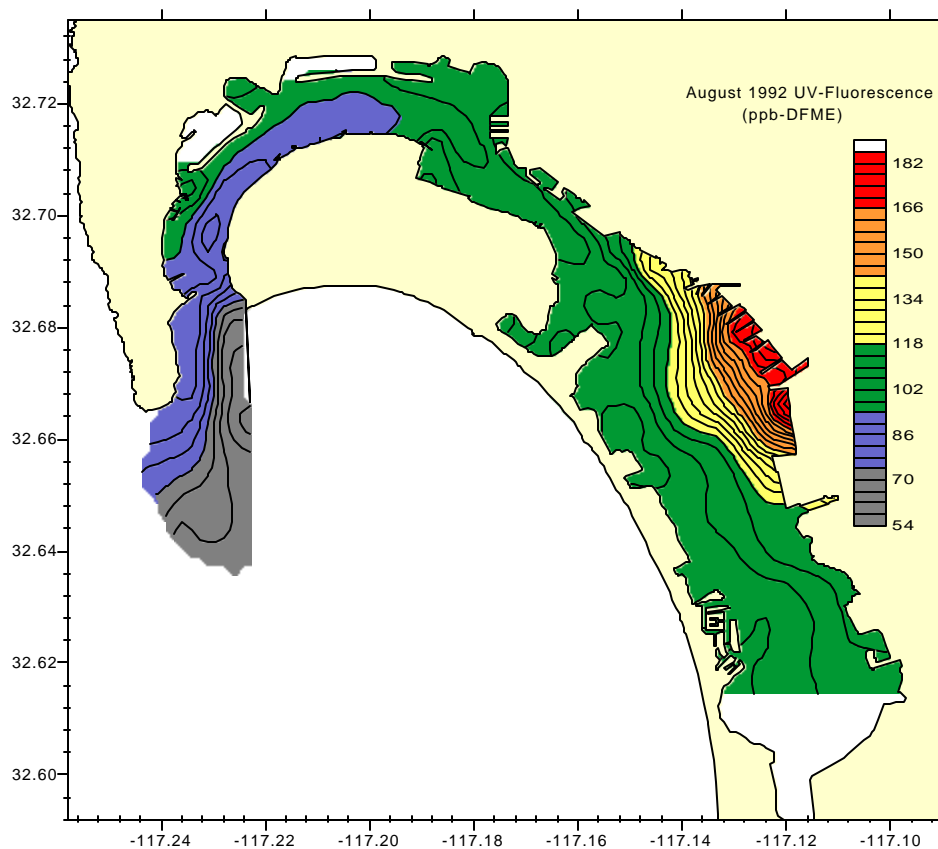
PAH Contaminant Source From Pilings

- PAH flux rates measured directly from in-place pilings
- Mass loading of PAH from NAVSTA pilings was ~1300 kg/year
- Represents ~80% of the TPAH source to the region
- Recent removal of pilings and bilgewater sources has resulted in ~10 fold reduction in PAH water concentrations

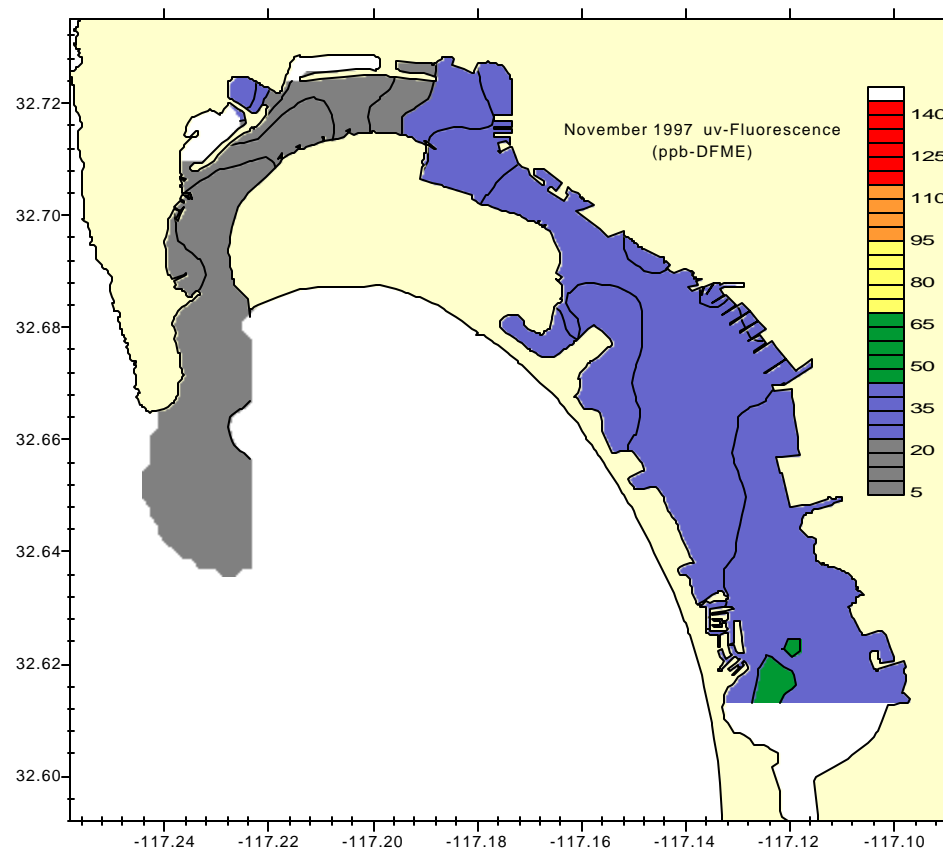


Long Term Monitoring PAH Distributions

1992 PAH



1997 PAH



Long-term monitoring data allowed NAVSTA San Diego to identify how changes in pollution control operations resulted in a significant reduction of PAH to San Diego Bay